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AUTHOR Whitman, Thomas L.; Taub, Susan Ilene
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ABSTRACT

The present experiments investigated the effects of several classical conditioning manipulations on the performance of young children in an instrumental discrimination learning situation. Two predictions from general conditioning-extinction theory were tested: (1) acquisition of an instrumental response to a stimulus for a positive reinforcer in a successive discrimination task situation should be facilitated if that same stimulus has been previously classically paired with a positive reinforcer; and (2) acquisition of an instrumental response to a stimulus should be inhibited if an incorrect stimulus in an identical successive discrimination task has been prepared classically with a positive reinforcer. Using first grade and nursery school children, the first prediction was generally confirmed. In contrast to expectation, the procedure described in the second prediction facilitated instrumental learning. Results were discussed within the context of House and Zeaman's attentional theory of learning and Kendler and Kendler's research on the reversal shift phenomenon. (Author)

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Two predictions from general conditioning-extinction theory were tested: (a) Acquisition of an instrumental response to a stimulus for a positive reinforcer in a successive discrimination task situation should be facilitated if that same stimulus has been previously classically paired with a positive reinforcer, and (b) acquisition of an instrumental response to a stimulus should be inhibited if an incorrect stimulus in an identical successive discrimination task has been prepaired classically with a positive reinforcer. Using first grade and nursery school children, the first prediction was generally confirmed. In contrast to expectation, the procedure described in the second prediction facilitated instrumental learning. Results were discussed with the context of House and Zeaman's attentional theory of learning and Kendler and Kendler's research on the reversal shift phenomenon.

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Transfer from a Classically Conditioned to an Instrumentally Learned Response

Thomas L. Whitman[1] and Susan Ilene Taub
University of Notre Dame

Much of the discrimination learning literature has dealt with variables that influence the rapidity of acquisition of different responses to different stimuli. Recently, in his review of children's learning, Stevenson (1970) suggested that in a discrimination problem situation a child must learn to attend to the stimuli involved and to isolate their distinctive characteristics before he can respond appropriately to a cue leading to reward. Similarly, House and Zeaman have more formally stressed in their theory the importance of attentional factors in discrimination learning (House and Zeaman, 1963).

In accordance with Stevenson's contention and the House and Zeaman model, any procedure which assists Ss in attending to the relevant stimuli in a discrimination situation would be expected to improve their subsequent discrimination. Fading (errorless discrimination) and stimulus pretraining (predifferentiation or acquired distinctiveness) techniques are two examples of such procedures. In the fading technique, the S is first presented with a simple problem in which there are many relevant cues and/or in which the irrelevant cues have been reduced. The problem is made more difficult by the gradual elimination of the redundant cues and/or the gradual introduction of the irrelevant cues (cf. Sidman & Stoddard, 1967). Thus, the "fading" technique "trains" the S to attend to relevant cues by stimulus shaping. In contrast, the "stimulus pretraining" technique requires the S to learn distinctive verbal responses to stimuli which are later used as discriminanda (cf. Cantor, 1955). The

rationale for the improved discrimination performance which results from the application of this procedure is that the distinctive verbal labels make the stimuli themselves more distinctive and thereby more salient (Miller & Dollard, 1941).

Another possible strategy for increasing the distinctiveness of cues in a discrimination learning task is suggested by a two-process learning theory which assumes that classical conditioning and instrument conditioning are separate and distinct processes which interact with each other. This two-process model of learning assumes: (a) that the laws of Pavlovian conditioning of the salivary reflex are probably laws either of emotional conditioning or laws of acquired drive; and (b) that conditioned emotional states change Ss' motivational level and thus serve as motivators or reinforcers of instrumental responses (Rescorla & Solomon, 1967). In effect, classical conditioning serves as an effective means of changing the incentive value of a stimulus in an instrumental situation.

Spence (1956), among others, has discussed the important role which classical conditioning may play in determining instrumental behavior. As Trapold and Winokur (1967) point out, Spence's incentive-motivation theory suggests that the establishment of a given stimulus (S) - response (R) connection which is followed by a reinforcer (S^R) should be influenced by the development of prior S-S^R associations (K), independent of the R. In those instances where the same stimulus (S) is employed first in classical and then in instrumental conditioning procedures, a "transfer of training" effect to the instrumental conditioning situation is predicted. Research studies with animals employing a variety of appetitive and aversive Pavlovian and instrumental conditioning procedures have basically supported this theory (cf. Solomon and Turner, 1962; Bower

and Grueneo, 1964; Estes, 1948; Trapold and Winokur, 1967). These aforementioned studies have examined the processes involved in nondifferential (one stimulus) acquisition and extinction. However, it has also been suggested that learning to respond to one stimulus but not to another also involves the same basic processes (cf. Trapold, Lawton, Dick and Gross, 1968).

Within human research, as in animal research, the discrimination learning situation has provided a structure for analyzing the relative effects of various reinforcement conditions. However, the effects of classical conditioning upon the performance of a human subject in this type of instrumental task need to be yet investigated. The present studies were designed to examine the efficacy of the classical conditioning procedure as a technique for systematically influencing the performance of young children in a discrimination learning situation. The purpose of the first experiment was to investigate specifically whether a classical conditioning manipulation would facilitate instrumental performance.

EXPERIMENT I

Two groups of Ss were given an identical instrumental discrimination learning problem in which stimuli were presented successively. Responses to one stimulus (S+, orange light) were always followed by an M&M reinforcement (S^R), while responses to a second stimulus (S-, green light) were never followed by reward. Prior to the instrumental learning situation, half of the Ss (facilitation group) received classical conditioning pairings of S+ with S^R (an M&M) and S- with S^{NR} (no reinforcer). The other Ss (control group) were exposed to both S+ and S- in the absence of S^R. Consistent with conditioning-extinction theories (cf. Kirble, 1961), it was predicted that a group receiving prior classical conditioning training would reach criterion sooner in an instrumental learning situation

than a group not given such training.

METHOD

Subjects

The Ss were 20 first-grade children enrolled at St. Matthew's Elementary School in South Bend, Indiana. The Ss were divided into subgroups on the basis of age (mean age = 84.8 months) and sex and were randomly assigned to the two treatment conditions.

Apparatus

The apparatus consisted of a $9\frac{1}{4}$ x $7\frac{1}{2}$ x 7 3/4 in. red wooden box. Two lights, orange and green, were mounted horizontally on the front panel. These lights were located two inches from the top of the panel and three inches apart from each other. A response key was centered $1\frac{1}{4}$ in. below the lights. The lights were programmed to occur in a fixed random sequence. M&Ms were automatically administered via a dispenser mounted on top of the apparatus. All stimulus presentations and reinforcement contingencies were automatically controlled by Lehigh Valley electromechanical equipment.

Procedure

Subjects were taken individually by an adult male E from their classroom to a small experimental room. The procedure at this point involved three separate phases: pretraining, classical conditioning, and instrumental conditioning.

Pretraining

Before initiating the classical conditioning procedure, each S was taught to play a new game. During this game situation, S learned to press the response key, in the absence of any lights, in order to obtain an M&M reinforcer. After a successful press, S was allowed to eat the M&M.

Classical Conditioning

During this period, all Ss passively observed both the orange and green lights flash on for two-second intervals in the same fixed random, successive sequence for 40 trials (light occurrences). In no instance did a specific light occur more than three times in succession.

For facilitation Ss, a reinforcer was contiguously associated with each occurrence of the orange light. More specifically, an M&M would fall into a tray in front of S, .5 sec. after the onset of the orange light. Thus, the sight of the food rather than the food itself was paired with the light. Subjects were not allowed to eat the M&Ms during this conditioning period. Control Ss were similarly exposed to the colored lights, but in the absence of any reinforcement. During this stage, the manipulandum was locked. The following instructions were given to each S:

As you can see, this toy has two lights on it--here and over here. (E points alternately to the lights.) What I want you to do during the first part of this game is to just sit and watch these two lights. (E points again to lights.) Now, I'm going to turn them on and I just want you to sit and watch these two lights. Okay, here we go.

Instrumental Conditioning

Immediately after the classical conditioning period, Ss in both groups were given the same discrimination task. The orange and green lights again occurred in a fixed random succession but for a longer interval of five seconds. A specific light, again, never occurred more than three times in succession. Reinforcers (M&Ms) were presented immediately contingent upon S's key-press response in the presence of the orange light. No reinforcers were dispensed during the on period of the green light. Subjects were not allowed to eat the M&Ms during this conditioning period.

The following instructions were given to each child:

Okay, now we are going to do something a bit different. This time I want you to press the lever like we did before, remember? Sometimes when you press the lever you will get an M&M and sometimes when you press the lever you won't. Press the key only when you think you can get an M&M. Remember, if you press the key at the right time you will get an M&M. One will fall into this tray (E points to tray) and if you press at the wrong time, you won't get an M&M. One won't come down. So you just want to press at the right time. Okay? Here we go. (If the child failed to press or pressed continuously to both lights, the instructions were repeated after ten trials.)

Each child was taken to a criterion of eight consecutive correct responses. If he did not reach this criterion by 100 trials (light occurrences), testing was discontinued. A S was scored as performing correctly on a given trial (light occurrence) if he pushed the key at least once during the occurrence of the orange light or if he did not push the key during the occurrence of the green light.

Response measures recorded were the trials to criterion, errors of omission, errors of commission, and total errors. An error of omission occurred when S failed to press during a presentation of S+. An error of commission resulted when S pressed at least once during an occurrence of S-. The total error score was the sum of these two separate error scores.

RESULTS AND DISCUSSION

The trials to criterion, errors of omission, errors of commission, and total error scores for the classical conditioning and control groups are presented in Table 1. A child who did not learn within 100 trials

was given a trials to criterion score of 100.

Insert Table 1 About Here

An analysis of variance with group and sex as factors was performed on each of these measures. These analyses revealed that none of the effects was statistically significant.

During the instrumental discrimination period, the tendency of Ss to press in perseverative fashion in the presence of both lights was noted. Examination of Table 1 also shows that errors of commission occurred with a much greater frequency than errors of omission in both the facilitation and control groups. These errors persisted even though after five successive incorrect presses, S was instructed again that a M&M would not be forthcoming if pressed at the wrong time and that he should just press at the right time.

Although the difference was not statistically significant ($F(1, 18) = 2.73$, $p < .12$), Ss in the facilitation group made fewer errors of omission than Ss in the control group (See Table 1). The direction of this difference is consistent with the prediction that the classical association of S^R with S+ would facilitate or increase the probability of a subject responding to S+ in the instrumental task situation.

Although Ss persisted in responding to S-, thereby increasing their error scores, this strategy was actually quite adaptive in that it minimized their chance of not receiving a reinforcer. Since the response required little physical effort on the S's part, the S was not penalized for "extra" responses, i.e., errors of commission, and thus he could ignore the lights completely. For this reason, a change in the reinforcement

procedures was initiated during the second experiment.

EXPERIMENT II

In order to counteract what appeared to be a child's tendency to maximize the probability of reinforcement by pressing the key regardless of which light (S+ or S-) was occurring, a penalty condition was introduced. Again, comparisons were made between the instrumental discrimination performances of a group which had prior classical pairing of S+ and S^R (facilitation) with a group which did not have such prior pairing (control).

METHOD

Subjects

Twenty-nine first-grade children enrolled in St. Matthew's Elementary School served as Ss. The Ss were divided into subgroups on the basis of age (mean age = 84.9 months) and sex and randomly assigned to the two treatment conditions.

Procedure

The apparatus and procedure were similar to that which was described in Experiment 1. However, a penalty as well as a reward procedure was instituted for all Ss during the instrumental conditioning phase. Also, the color of S+ was counter-balanced over the two treatment conditions such that half of the Ss in both groups had the orange light designated as the S+ while for the remaining Ss, S+ was the green light. Prior to initiation of the instrumental discrimination training task, all Ss in this experiment were given the additional instruction that, "If you press at the wrong time, I am going to take one (M&M) away." During the discrimination task, E, upon S's emission of an error of commission, would reach into the tray where the M&Ms were delivered and take out one, placing it out of the child's sight.

RESULTS AND DISCUSSION

The trials to criterion, errors of omission, errors of commission and total error scores for the two training groups are presented in Table 2. Because the sex factor in the four sex-by-group analyses of variances did not approach significance as a main effect or in interaction with the group factor (all Fs $(1,25) < 1$), this factor was collapsed and simple comparisons between groups were conducted.

Insert Table 2 About Here

The group effect reached significance for the trials to criterion ($t(27) = 1.93$, $p < .05$), errors of omission ($t(27) = 1.74$, $p < .05$) and total error ($t(27) = 1.77$, $p < .05$) scores. As is shown in Table 2, the direction of differences points out that the facilitation group learned more rapidly (fewer trials to criterion) and with fewer errors than the control group.

A comparison between the error data of Experiments I and II suggests that the penalty procedure introduced in this second experiment had its intended effect. While the errors of omission were almost identical for facilitation and control Ss in the two studies, Ss in both groups in Experiment II show a marked reduction in errors of commission (See Tables 1 and 2). In summary, the results suggested that the classical association of the light cue with the M&M reinforcer facilitated Ss' performance in the instrumental discrimination situation.

EXPERIMENT III

In order to assess the reliability of the results of Experiment II, a replication was run with a similar subject population. In addition, a third group (inhibition) was added to assess the effect of classically

associating an M&M reinforcer with a cue (S-) that was later to be designated as incorrect in the instrumental test situation. According to conditioning-extinction theory (cf. Trapold, 1968), this manipulation should not facilitate operant performance, but rather through an increment in errors of commission, should lead to poorer performance.

METHOD

Subjects

Forty-six first-grade children from Christ the King Elementary School served as Ss. The children were assigned, controlling for age (mean age = 87.1 months) and sex, to the two experimental groups and the control group.

Procedure

The apparatus and procedure for the facilitation and control groups were identical with that which was previously described in Experiment II. The procedure followed for Ss in the inhibition group was identical with that for the facilitation group Ss, except that during the classical conditioning period S^R (M&Ms) was now temporally associated with the cue (S-) and not with cue (S+).

RESULTS AND DISCUSSION

Table 3 presents the mean trials to criterion and error data for the facilitation, inhibition, and control groups. Because the sex factor as a main effect or in interaction with the group factor again failed to approach significance inthe 2X2 analyses of variances ($F < 1$ in all instances), this factor was collapsed and simple one-way analyses of variance were conducted. The group effect reached significance for the trials to criterion ($F(2,43) = 6.40$, $p < .01$), errors of omission ($F(2,43) = 4.71$, $p < .05$) and total errors ($F(2,43) = 5.76$, $p < .01$) scores.

Comparisons between group means for these three scores were made retaining the overall mean square error term. Because the number of

Ss per cell varied at most by one S, the comparisons were calculated by assuming all groups had equal n's and estimating the group totals from the group means. This required using one less degree of freedom for the mean square error term.

Insert Table 3 About Here

On the trials-to-criterion and both error measures, the facilitation and inhibition groups were significantly different from the control group ($p < .05$) but were not significantly different from each other. As Table 3 indicates, Ss in both the facilitation and inhibition groups learned faster and with fewer errors than the control group Ss. The relative performances of Ss in the facilitation and control groups are quite similar to that found in Experiment II.

In contrast to predictions that would be expected from general conditioning-extinction theory, Ss in the inhibition group and in the facilitation group performed similarly in the operant task situation. If the Zeaman and House attentional model of discrimination learning is adopted, a different prediction might be made (Zeaman and House, 1963). Within their model, the child passes through two distinctive stages in learning a problem: (a) he first learns to attend to the dimension relevant to solution; and (b) he then discovers the value along that dimension which leads to reward. According to the Zeaman and House model, the first stage is the most difficult and produces most of the variation found among Ss. Moreover, any procedure that assists Ss in attending to the relevant stimulus dimensions should improve their performance on discrimination

problems. Pairing the S^R with the S- and the absence of S^R with S+ during classical conditioning might serve merely to focus the S's attention on the color dimension. He would then on the instrumental learning task be required to change only the value along the color dimension that is associated with reward. Thus, the "inhibition" group would also be expected to perform better than the control group.

EXPERIMENT IV

According to Kendler and Kendler (1962), nonreversal shifts are easier for preschool children than reversal shifts. They suggest that while a young child attends to the specific attributes of the dimension and thereby has trouble in discrimination situations requiring a reversal shift, the older child does not have this problem because he becomes aware of a total dimension in the process of learning to respond differentially to an attribute of a dimension. This theory, thus, could be paired with the Zeaman and House (1963) model to explain the improved performance of the first-grade Ss in Experiment III who were in the inhibition group. That is, it is possible that the classical pairing of the reinforcer with the incorrect one brought the color dimension to the inhibition S's attention. In contrast, inferring from Kendler and Kendler's theory, the classical association of S^R with S- would not be expected to facilitate instrumental performance of a younger child if he is attending only to the absolute attributes of a dimension rather than the dimension itself.

In an attempt to assess whether younger children would benefit from the classical conditioning procedure and would perform similarly to the older children in Experiment III, this last experiment was conducted.

METHOD

Subjects

Thirty-four children from Seven Dwarfs Nursery School in Elkhart, Indiana served as Ss. The children, ranging in age from 45 to 69 months (Mean age = 54.5 months), were assigned, controlling for age and sex, to the two experimental (facilitation and inhibition) groups and the control group.

Procedure

The procedure was identical to that which was previously described in Experiment III.

RESULTS AND DISCUSSION

The trials to criterion, errors of omission, errors of commission and total error scores for the experimental and control groups are presented in Table 4. Simple one-way analyses of variance were again conducted on the trials-to-criterion and error scores. The group effect reached significance for the trials to criterion, $F\ (2,31) = 4.90\ p < .05$, and the total error scores, $F\ (2,31) = 4.45\ p < .05$. Comparisons between group means were again made by the technique described in Experiment III.

Insert Table 4 About Here

For both the trials-to-criterion data and total error scores, the inhibition group was significantly different from the control group but not from the facilitation group. There were no differences between the facilitation and control groups for either of these scores. The fact that no difference was found between these two latter groups is probably a result of the number of trials administered. While no S in the control group

achieved criterion with 100 trials, four Ss in the facilitation group and seven in the inhibition group reached criterion. If a greater number of trials had been administered, the difference between the control and facilitation groups would probably have been significant.

In general, the direction of differences between the experimental groups for the younger Ss generally parallels those of the older Ss in Experiment III. However, as may be seen from Tables 3 and 4, the younger Ss consistently made more errors. Of more interest are the individual experimental and control group performances. In the third experiment, all 16 of the facilitation Ss learned, 13 of the 15 inhibition Ss learned, and 10 of the 15 control Ss learned. Thus, the classical conditioning procedure reduced the frequency of non-learners. It should also be noted that it speeded up the learning process. In the fourth experiment with the younger Ss, 4 of the 12 facilitation Ss learned, 7 of the 11 inhibition Ss learned, and none of the 11 control Ss learned. Thus, learning occurred only for the younger Ss who had received the classical conditioning procedure.

Although Kendler and Kendler suggested that reversal shifts could not be made by young children, the performance of the inhibition group suggests that such shifts might occur. However, it should be stressed that the Ss in the present study had a mean age of 54.5 months. Thus, they might have already entered "the point in human development. . .which was psychologically halfway between the white rat and the college student." (Kendler & Kendler, 1962).

In general, the data from the last three experiments show that manipulations carried out in the classical conditioning paradigm produce changes in an instrumental learning situation. In contrast to general conditioning-extinction theory, the classical association of a reinforcer

with a cue (S-) facilitates the later acquisition of a differential instrumental response to another cue (S+) of the same dimension. This finding is consistent with predictions made from an attentional theoretical framework.

Perhaps more important than the theoretical implications of the results in these four experiments is their educational implication. The results of these studies suggest that traditional operant methods for teaching children discriminations can be augmented by first systematically associating within a classical conditioning paradigm cues to be later discriminated and differentially responded to with positive reinforcement. Conversely, the etiology of discrimination problems and the difficulty children have in manipulating symbols (e.g., numbers) might be attributed to the fact that such symbols have never been associated with positive reinforcement.

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TABLE 1

Mean Trials to Criterion and Mean Error Scores

for Facilitation and Control Groups

Group	Trials to Criterion	Errors of Omission	Errors of Commission	Total Errors
Facilitation (N=10)	47.80	.70	18.50	19.20
Control (N=10)	54.10	7.10	15.90	23.00

TABLE 2

Mean Trials to Criterion and Mean Errors for the Facilitation and Control Groups

Group	Trials to Criterion	Errors of Omission	Errors of Commission	Total Errors
Facilitation (N=14)	17.36	1.07	4.00	5.07
Control (N=15)	40.67	6.53	9.47	16.00

TABLE 3

Mean Trials to Criterion and Mean Error Scores for the Facilitation, Inhibition and Control Groups

Group	Trials to Criterion	Errors of Omission	Errors of Commission	Total Errors
Facilitation (N=16)	13.94	1.44	1.56	3.00
Inhibition (N=15)	24.40	3.27	5.07	8.33
Control (N=15)	52.20	13.60	7.20	20.80

TABLE 1

Mean Trials to Criterion and Mean Error Scores for the Facilitation, Inhibition and Control Groups

Group	Trials to Criterion	Errors of Omission	Errors of Commission	Total Errors
Facilitation (N=12)	79.92	19.58	17.50	37.08
Inhibition (N=11)	59.72	16.46	11.37	27.83
Control (N=11)	100.00	24.91	24.45	49.36

Footnote

[1]Requests for reprints should be sent to Thomas L. Whitman, Department of Psychology, University of Notre Dame, Notre Dame, Indiana 46556